Development and Validation of a Black Carbon Mixing State Resolved Three-Dimensional Model

Research Highlight

A new two-dimensional aerosol bin scheme has been developed and implemented into the MS-resolved WRF-chem model. In collaboration with researchers at Pacific Northwest National Laboratory, scientists at the University of Tokyo extended the MOSAIC aerosol model, developed by the DOE's Atmospheric System Research (ASR) program, to include a treatment of black carbon mixing states in the atmosphere.

Their results show that the model can simulate realistic black carbon mixing states in the atmosphere if microphysical processes, such as condensation and coagulation, are calculated explicitly with the detailed treatment of black carbon mixing state. Black carbon particles are gradually coated by other species through condensation, coagulation, and/or photochemical oxidation processes in the atmosphere (called aging processes) and become "internally mixed" particles. Measurements taken over East Asia found sensitivity calculations for microphysical processes and emissions that affect black carbon mixing states and spatial variability of black carbon mixing states. The new two-dimensional aerosol bin representation consisted of one dimension aerosol dry diameter (12 bins between 40 nm and 10 µm) and the other dimension is the black carbon mass fraction of the total aerosol mass concentration under dry conditions (10 bins).

Model simulations generally reproduced the observed features of black carbon mixing state, such as the temporal variations and size dependencies of the following parameters: number fraction of black carbon-containing and black carbon-free particles, the range and fraction of shell (total particle dry diameter)-to-black carbon core diameter ratio (SC ratio), and mean SC ratio. Both observed and calculated mean SC ratios tended to be higher when aerosol mass concentrations were high, likely due to faster black carbon aging processes within stagnant air.

Reference(s)

Matsui H, M Koike, Y Kondo, N Moteki, JD Fast, and RA Zaveri. 2013. "Development and validation of a black carbon mixing state resolved three-dimensional model: Aging processes and radiative impact." Journal of Geophysical Research – Atmospheres, , doi:10.1029/2012JD018446. ACCEPTED.

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Working Group(s)

Aerosol Life Cycle